1849MNRAS...9...49B

HAMBURG. (M. C. Rümker.)

1848.	Hamburg M.T.	R.A.	No. Obs.	Decl.	No. Obs.
	h m s	° ′ ″		° ′ ″	
Dec. 1	7 33 35·3		2	+29 52 10·0	1
	7 41 26·1	20 59 41·80			
5	6 57 35	21 15 39·35		24 24 42·5	
10	6 58 11·8	34 54·45	7	17 24 57·7	7
11	6 13 17·2	21 38 29·73	6	+16 4 31·8	6
24	6 53 12·0	22 23 11·97	4	− 0 58 33·1	4
28	7 26 35·3	35 38·75	6	5 35 43·8	6
29	6 57 49·0	22 38 35·67	8	− 6 40 28·7	8

Not corrected for parallax or refraction.

Corrections of Lindenau's Elements of the Orbit of Venus, deduced from the Greenwich Planetary Observations, 1750–1830. By Mr. Hugh Breen, of the Royal Observatory, Greenwich.

In the Greenwich observations from 1750 to 1830 are contained upwards of one thousand observations of *Venus*, and it seems plain that corrections of the elements of her orbit deduced from so extensive a series of observations must be valuable. Impressed with this conviction, the late Mr. Hugh Breen commenced this work, which has been brought to completion by the author with the assistance of his brother, Mr. James Breen, of the Cambridge observatory.

Lindenau's corrected elements of the epoch 1750 were deduced from Bradley's Greenwich observations, 1750–1756. When the places used by him are compared with those given in the Greenwich Planetary Reductions sensible differences are frequently found. In 23 cases out of 78, the difference of R.A. exceeds 5″; and in finding the N.P.D. Lindenau appears to have overlooked the index error of the iron quadrant from 1750–1753, which in some instances amounted to 14″.

If the solar tables be supposed to be correct, and the perturbations of *Venus* to be rightly tabulated, any error in the computed place can only arise from errors in the elements of the orbit employed in constructing the tables. In the Greenwich Reductions, the error of geocentric longitude for each mean group of observations is expressed in terms of the errors of heliocentric longitude and radius vector.

By an investigation which the author gives, and which besides is well known, these latter errors may be expressed in terms of the errors of the elements. Since the inclination of the orbit is small, the reduction to the ecliptic may be supposed to be exactly known, and the error of longitude will be nearly independent of the errors of the node and inclination. Hence each mean group of observations furnishes an equation of condition between the errors of the

1849MNRAS...9...49B

mean distance, the eccentricity, the epoch of mean longitude, and the longitude of the aphelion. The formation of the equations is given in a series of tables, and in such detail that any portion of the work may be readily verified. The 254 equations thus formed are then divided into groups of convenient extent, and each group is separately solved in the following manner. Each equation of condition is multiplied by the number of observations on which it depends, and the resulting equations are combined by addition, after changing the signs so that the co-efficients of each of the unknown quantities in succession are made positive.

The errors of the tabular elements obtained for different periods are given in the following table:—

No. of Eqns.	Extent of Group.		δa	δe	$\delta\epsilon$	$\delta\pi$
					″	″
1–33	1750 Oct. 13,	to 1755 July 28	+0·0000179	+0·0000145	−2·81	−55·2
34–68	1756 Mar. 5,	1761 Nov. 11	0·0000111	0·0000179	3·46	87·2
69–104	1762 July 5,	1769 Aug. 10	0·0000039	0·0000134	5·28	141·1
34–57	1756	1759	0·0000167	0·0000233	6·87	14·9
58–80	1759 Sept. 19,	1763 Aug. 29	0·0000071	+0·0000130	1·71	98·9
122–140	1788 May 29,	1799 Dec. 26	0·0000037	−0·0000087	−0·76	−403·7
147–158	1811 Aug. 24,	1818 June 1	0·0000118	0·0000012	+3·52	+ 81·7
159–200	1819 Feb. 15,	1822 Dec. 1	0·0000111	0·0000099	+1·00	−238·2
201–227	1823 Mar. 23,	1826 Aug. 30	0·0000046	0·0000219	−1·67	269·2
228–254	1828 Feb. 15,	1830 Nov. 16	+0·0000111	−0·0000145	−2·34	−351·8

The first group consists of the observations from which Lindenau derived his corrections of Lalande's Elements at the epoch 1750.

The errors of heliocentric ecliptic solar distance are next treated in a similar manner to those of the longitude.

As the inclination of the orbit is small, the errors of longitude, which are themselves in general small, will produce only an inappreciable effect on the errors of ecliptic polar distance, which may, therefore, be taken to depend solely on the errors of the node and inclination. The equations of condition are consequently very simple, and each group has been solved by the method of least squares. The following table gives the resulting errors of the elements:—

No. of Eqns.	Extent of Group.		$\delta N.$	$\delta I.$
			″	″
1–33	1750 Oct. 13,	to 1755 July 28	+ 90·6	−8·27
34–57	1756 March 5,	1759 Aug. 3	108·5	4·05
58–80	1759 Sept. 19,	1763 Aug. 29	115·5	7·08
81–104	1764 Jan. 31,	1769 Aug. 10	94·5	5·07
122–140	1788 May 29,	1799 Dec. 26	30·5	3·76
147–158	1811 Aug. 24,	1818 June 1	25·6	4·54
159–200	1819 Feb. 15,	1822 Dec. 1	43·8	3·18
201–227	1823 March 23,	1826 Aug. 30	34·3	4·57
228–254	1828 Feb. 15,	1830 Nov. 16	+ 7·4	−2·21

1849MNRAS...9...51R

The large errors of the node and inclination at the epoch 1750–1755, probably arise from the neglect of the index error of Graham's quadrant, from 1750–1753, before mentioned.

On that Part of the Equation of Time which Depends on the Obliquity of the Ecliptic. By John Riddle, Esq.

"Let ω = obliquity; l = sun's longitude; a = sun's right ascension; δ = sun's declination.

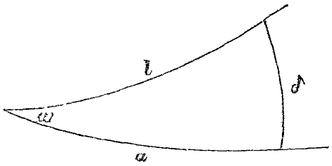
Then $l-a = x$ = that part of the equation of time here spoken of.

Now, $$\cos\omega = \tan a \,.\, \cot l,$$

or $$\frac{\cos\omega}{1} = \frac{\tan a}{\tan l}$$

$$\frac{1+\cos\omega}{1-\cos\omega} = \frac{\tan l + \tan a}{\tan l - \tan a};$$

or $$\cot^2\frac{\omega}{2} = \frac{\sin(l+a)}{\sin(l-a)} = \frac{\sin(l+a)}{\sin x}$$



$$\therefore \quad \sin x = \sin(l+a) \,.\, \tan^2\frac{\omega}{2}.$$

"From this it is evident that $\sin x$ and $x = 0$ when $\sin(l+a) = 0$, that is, when $l+a = 0$; 180°; 360°; or 540°; and these values of $l+a$ occur at the equinoxes and solstices.

"The greatest values of $\sin x$ and of x correspond to the greatest value of $\sin(l+a)$, viz. when

$$l+a = 90^\circ,\ 270^\circ,\ 450^\circ \text{ or } 630^\circ,$$

and $$\sin(l+a) = \quad 1, \quad -1, \quad 1 \text{ or } -1;$$

which will give x alternately positive and negative; if X be the maximum value of x,

$$\sin \mathrm{X} = \pm \tan^2\frac{\omega}{2} \ \ldots\ldots\ldots\ldots \ 1$$

"Again, when $$l+a = 90^\circ$$

$$2\,l-(l-a) = 90^\circ$$

or $$2\,l-\mathrm{X} = 90^\circ$$

and $$l = \tfrac{1}{2}\,(90^\circ+\mathrm{X}) \ \ldots\ldots\ldots \ 2$$

and $$a = (90^\circ - l) \ \ldots\ldots\ldots \ 3$$

"Also, when $x = \mathrm{X}$,

$$\cos l = \cos a \,.\, \cos\delta$$

$$= \sin l \,.\, \cos\delta \quad (\cos a = \sin l, \text{ equat. } 3)$$

$$\therefore \ \cot l = \cos\delta \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \ 4$$

"The equations (1), (2), (3), (4), furnish an easy means of finding